

UNITED STATES PATENT APPLICATION

ELECTRONIC ASSEMBLY WITH INTEGRATED
IO AND POWER CONTACTS

INVENTOR:

Donald T. Tran

Schwegman, Lundberg, Woessner & Kluth, P.A.
1600 TCF Tower
121 South Eighth Street
Minneapolis, MN 55402
ATTORNEY DOCKET NO. 884.B83US1
INTEL NO. P18300

5 Some example embodiments of the present invention relate to an integrated circuit and electronic assembly that include a processor, and more particularly, an integrated circuit, an electronic assembly and method with an improved design for providing power to the processor.

The current paths in integrated circuits and other electronic assemblies that include processors are continually being required to handle ever-increasing amounts of current in order power the processors. Processors typically require more power in order to operate at higher frequencies and to simultaneously perform numerous logic and memory operations.

One drawback of such designs is that they require a separate power connector. The power connector adds unwanted expense to the cost associated with producing electronic systems that include processors. In addition, the substrate where the processor is mounted typically needs to be relatively thick so that the LGA socket, which is situated beneath the substrate, is able to withstand substantial compression loading.

Client Ref. No. P18300

the power connector on the daughter card. Elongating and/or widening the substrate where the processor is mounted uses up precious space within electronic systems that include processors and is not cost effective since a typical substrate is relatively expensive.

5 In some electronic assemblies, the substrate where the processor is mounted is susceptible to warping that is induced by residual stress within the substrate. There is typically residual stress within the substrate as a result of the manufacturing processes that are associated with producing a package that includes a die mounted on a substrate.

10 When such a package is mounted against a land grid array (LGA) on a socket, a high compression force is required to ensure proper connection with the contacts in the LGA. A typical LGA on a socket may include over 1000 contacts such that a compression load of more than 150 lbf needs to be applied between the package and the socket. The die and the substrate within the package are
15 vulnerable to failures (e.g., cracking and/or delaminating) when such a relatively high compression load is applied between the package and the socket.

 There is a need for an electronic assembly where the size of a substrate that is within a package mounted to an LGA on a socket is reduced to minimize cost and save space. In addition, the LGA that forms part of the connection between the
20 package and the socket should be capable of withstanding a compression load that is required to ensure proper connection with the contacts in the LGA without risk of damage to the components in the package.

BRIEF DESCRIPTION OF THE DRAWINGS

25 Figure 1 is a schematic section view of an integrated circuit.

 Figure 2 is a perspective view of the integrated circuit shown in Figure 1.

 Figure 3 is a schematic section view illustrating an electronic assembly that incorporates the integrated circuit shown in Figures 1 and 2.

 Figure 4 is a block diagram of an electronic system that incorporates the
30 electronic assembly shown in Figure 3.

Figure 5 illustrates a method that includes engaging power contacts that extend from an upper surface of a base with a daughterboard that includes a voltage source.

5

DETAILED DESCRIPTION

The following detailed description references the accompanying drawings. Like numerals describe substantially similar components throughout each of the drawings. Other embodiments may be used, and structural, logical, and electrical changes made. The integrated circuit described herein can be manufactured, used, or shipped in a number of positions and orientations.

10

In some embodiments, the integrated circuit, electronic assembly and method provide a current path for supplying power to a processor. Power is supplied to a processor, or die, using power contacts that extend from an upper surface of a base which supports a substrate where the die is mounted. The configuration allows the substrate size to be minimized. In addition, the components within the integrated circuit and electronic assembly are more readily able to handle compressive loads when the components are compressed together.

15

Figures 1 and 2 illustrate an integrated circuit 10 that includes a base 12 having power contacts 14 which extend from an upper surface 16 of base 12.

Integrated circuit 10 further includes a substrate 18 mounted to the upper surface 16 of base 12 such that substrate 18 is electrically coupled to base 12. A die 20 is mounted on substrate 18 such that die 20 is electrically coupled to substrate 18.

20

As shown in Figure 3, power contacts 14 on the upper surface 16 of base 12 engage a daughterboard 40 so that current may be supplied to die 20 from a voltage source 42 (e.g., voltage regulator) mounted on daughterboard 40. During operation of integrated circuit 10, most of the current may be supplied to die 20 through power contacts 14.

25

The upper surface 16 of base 12 may further include a recess 17 such that substrate 18 is mounted within recess 17. It should be noted that although substrate 18 and recess 17 are shown as square-shaped, substrate 18 and recess 17 may be any

30

size and shape. In some forms, substrate 18 may be surface mounted to the upper surface 16 of base 12.

In other embodiments, base 12 further includes I/O contacts 22 that extend from a bottom surface 24 of base 12. Power contacts 14 may be blade type while
5 I/O contacts 22 may be formed in a large grid array. Although power contacts 14 are shown in Figure 2 as being positioned in a staggered arrangement along each side of substrate 18, power contacts 14 may be positioned along one or more sides of substrate 18. In addition, the number, size, type and arrangement of power contacts 14 and I/O contacts 22 may vary depending on the design of integrated
10 circuit 10. I/O contacts 22 may be located directly below die 20 to minimize the distance between I/O contacts 22 and die 20.

The power contacts 14 may be made of metal that is up to three times thicker than contacts in existing integrated circuits that supply power to a processor using a voltage source mounted on a daughterboard. The thicker contacts reduce parasitic
15 resistance within the integrated circuit 10 and make integrated circuit 10 more robust when it is assembled into an electronic assembly (see, e.g., electronic assembly 50 in Figure 3). In some forms, a tip of each power contact 14 may be rolled inward to make it less susceptible to handling damage.

In some forms, base 12 is made of a material (e.g., plastic) that is adapted to
20 handle compressive loads. One example material for base 12 is a liquid crystal polymer, although other materials may also be used.

In some forms, die 20 may be made of semiconducting material that has been separated from a wafer. Wafers may be made of semiconducting, non-semiconducting, or combinations of semiconducting and non-semiconducting
25 materials. In some embodiments, a heat spreader 21 may be coupled to die 20 to remove heat from die 20 during operation of integrated circuit 10.

Figure 3 illustrates an example embodiment of an electronic assembly 50 that includes integrated circuit 10. Electronic assembly 50 may include a motherboard 52 positioned adjacent to the bottom surface 24 of base 12 such that
30 motherboard 52 is electrically coupled to base 12 (e.g., through I/O contacts 22). As

discussed above, electronic assembly 50 further includes daughterboard 40 that engages power contacts 14 on the upper surface 16 of base 12 to electrically couple one or more voltage sources 42 on daughterboard 40 to die 20.

Electronic assembly 50 may further include a heat sink 23 that is coupled to
5 heat spreader 21. In some forms, heat sink 23 may be coupled directly to die 20.

In some embodiments, electronic assembly 50 further includes one or more fasteners 54 that compress base 12 against motherboard 52 and daughterboard 40. Figure 3 shows that fasteners 54 may be used to secure electronic assembly 50 to a chassis 60 such that motherboard 52, base 12 and daughterboard 40 are compressed
10 between heat sink 23 and chassis 60. The fasteners 54 may apply a relative high compression load (>200 lbs), however the majority of the compression load is supported by power contacts 14 and the upper surface 16 of base 12 instead of heat spreader 21, die 20 and substrate 18. Since less of the compression load is applied to die 20 and substrate 18, there is a reduced possibility of damage to electrical
15 connections within the electronic assembly 50.

In the example embodiment illustrated in Figure 3, motherboard 52 is rigidly supported on chassis 60. Four fasteners 54 (e.g., bolts) extend across heat sink 23 through holes 55 (see Figure 2) at each corner of base 12 (only two fasteners 54 and holes 55 are shown in Figure 3). Fasteners 54 extend through motherboard 52 and
20 are threaded into chassis 60.

As the fasteners 54 are tightened, a compressive force is generated on base 12, I/O contacts 22, heat spreader 21 and heat sink 23. In some embodiments, base 12 may include one or features 13 that serve as a stop. These stopping features 13 (see Figures 1 and 3) prevent electronic assembly 50 from being over-compressed
25 and ensure that the I/O contacts 22 are compressed down to an acceptable height when fasteners 54 secure electronic assembly 50 to chassis 60.

Integrated circuit 10 may be adapted for use with other components in an electronic assembly. In some embodiments, the components in an electronic assembly will be determined based on the space available and the application where
30 the electronic assembly is to be used (among other factors). It should be noted that

the configuration of integrated circuit 10 may also allow the overall height (i.e., thickness) of an electronic assembly that includes integrated circuit 10 to be reduced because the power contacts are part of base 12.

FIG. 4 is a block diagram of an electronic system 70 incorporating at least one electronic assembly (e.g., electronic assembly 50 shown in Figure 3) described herein, which includes one or more types of integrated circuits (e.g., integrated circuit 10 shown Figures 1 and 2) described herein. Electronic system 70 may be a computer system that includes a system bus 72 which electrically couples the various components of electronic system 70 together. System bus 72 may be a single bus or any combination of busses.

Electronic assembly 50 is electrically coupled to system bus 72 and may include any circuit, or combination of circuits. In one embodiment, electronic assembly 50 includes one or more of the integrated circuits 10 described herein. Integrated circuit 10 may include a processor which can be of any type. As used herein, processor means any type of circuit such as, but not limited to, a microprocessor, a microcontroller, a graphics processor or a digital signal processor.

Other types of circuits that may be included in electronic assembly 50 are a custom circuit or an application-specific integrated circuit, such as communications circuit 77 for use in wireless devices such as cellular telephones, pagers, portable computers, two-way radios, and similar electronic systems.

Electronic system 70 may also include an external memory 80 that in turn may include one or more memory elements suitable to the particular application, such as a main memory 82 in the form of random access memory (RAM), one or more hard drives 84, and/or one or more drives that handle removable media 86, such as diskettes, compact disks (CDs) and digital video disks (DVDs).

The electronic system 70 may also include a display device 88, a speaker 89, and a controller 90, such as a keyboard, mouse, trackball, game controller, microphone, voice-recognition device, or any other device that inputs information into the electronic system 70.

The integrated circuits and electronic assemblies described herein may be implemented in a number of different embodiments, including an electronic package, an electronic system, a computer system, one or more methods of fabricating an integrated circuit, and one or more methods of fabricating an electronic assembly that includes the integrated circuit. The elements, materials, geometries, dimensions, and sequence of operations can all be varied to suit particular packaging requirements.

Figure 5 illustrates one example embodiment of a method 100 that includes 110 attaching a die to a substrate and 120 attaching the substrate to an upper surface of a base. The method further includes 130 engaging power contacts that extend from the upper surface of the base with a daughterboard that includes a voltage source and 140 supplying power from the voltage source to the die using the power contacts. In some embodiments, 120 attaching the substrate to an upper surface of a base includes (i) surface mounting the substrate to the base; and/or (ii) mounting the substrate within a recess in the upper surface of the base.

The method may further include (i) 150 attaching a motherboard to a bottom surface of the base; (ii) 160 securing the motherboard and the daughterboard to a chassis; (iii) 170 attaching a heat spreader to the die; and/or (iv) 180 attaching a heat sink to the heat spreader. It should be noted that 160 securing the motherboard and the daughterboard to a chassis may include compressing the base, the substrate and the die between the motherboard and the daughterboard.

Figures 1-5 are merely representational and are not drawn to scale. Certain proportions thereof may be exaggerated while others may be minimized.

The integrated circuit described above provides a solution for supplying power to processors that are powered by high currents. The design of the integrated circuit improves the reliability and overall system cost as compared to existing integrated circuits where processors are powered by a voltage source on a daughterboard. Many other embodiments will be apparent to those of skill in the art from the above description.